

# A Hybrid Network Platform for Collaborative Applications

Sauleh Eetemadi (Michigan State University)

Jason Van Eaton (Microsoft Research)

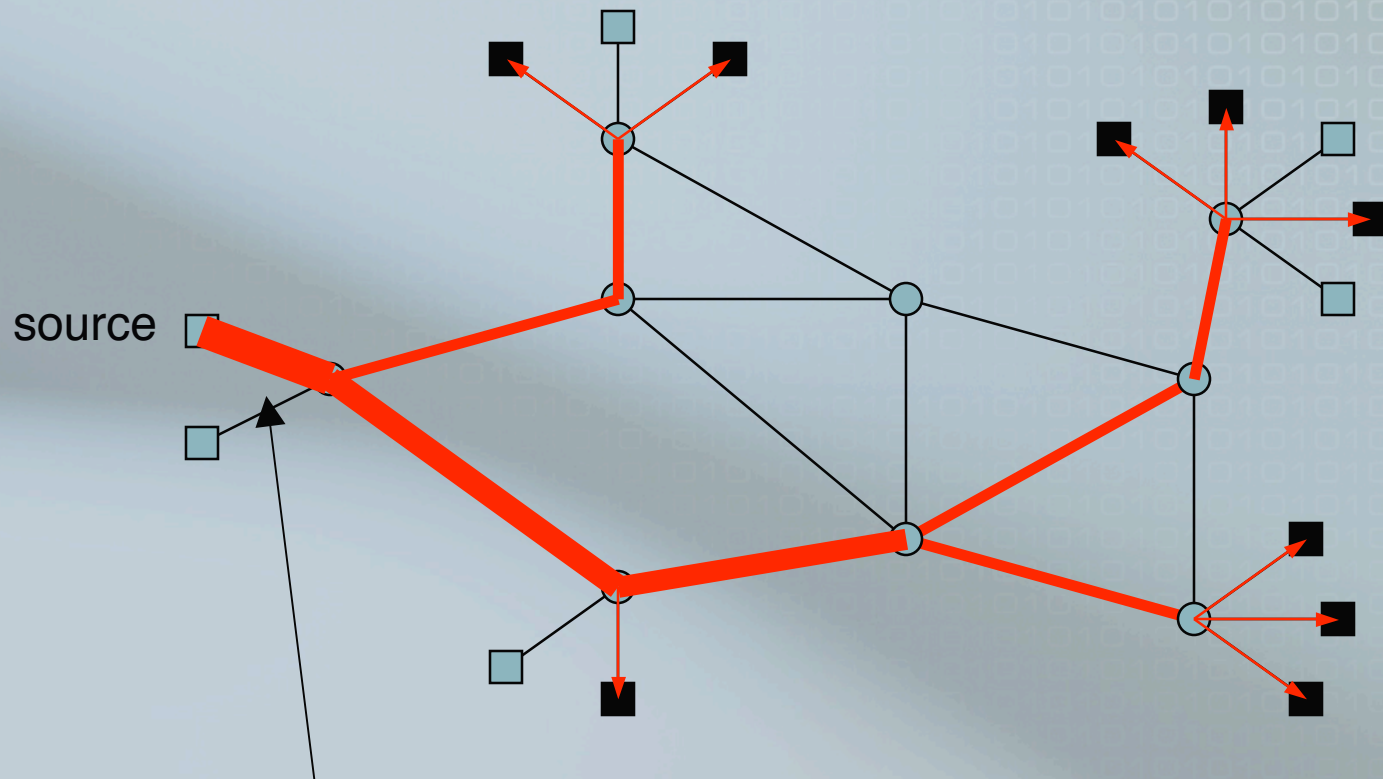
# Outline

- What is multicast?
- Why IP-multicast is not fully deployed?
- Alternatives to IP-multicast
- Multi-Reflector Service developed by Microsoft Research
- The Multicast Game

# What is multicast?

- Multicast is a type of traffic destined to a group of users (one-to-many type of traffic)
- IP-Multicast: The first attempt to design a highly efficient and scalable router level multicast protocol in the TCP/IP protocol stack.

# If IP Multicast is not enabled...



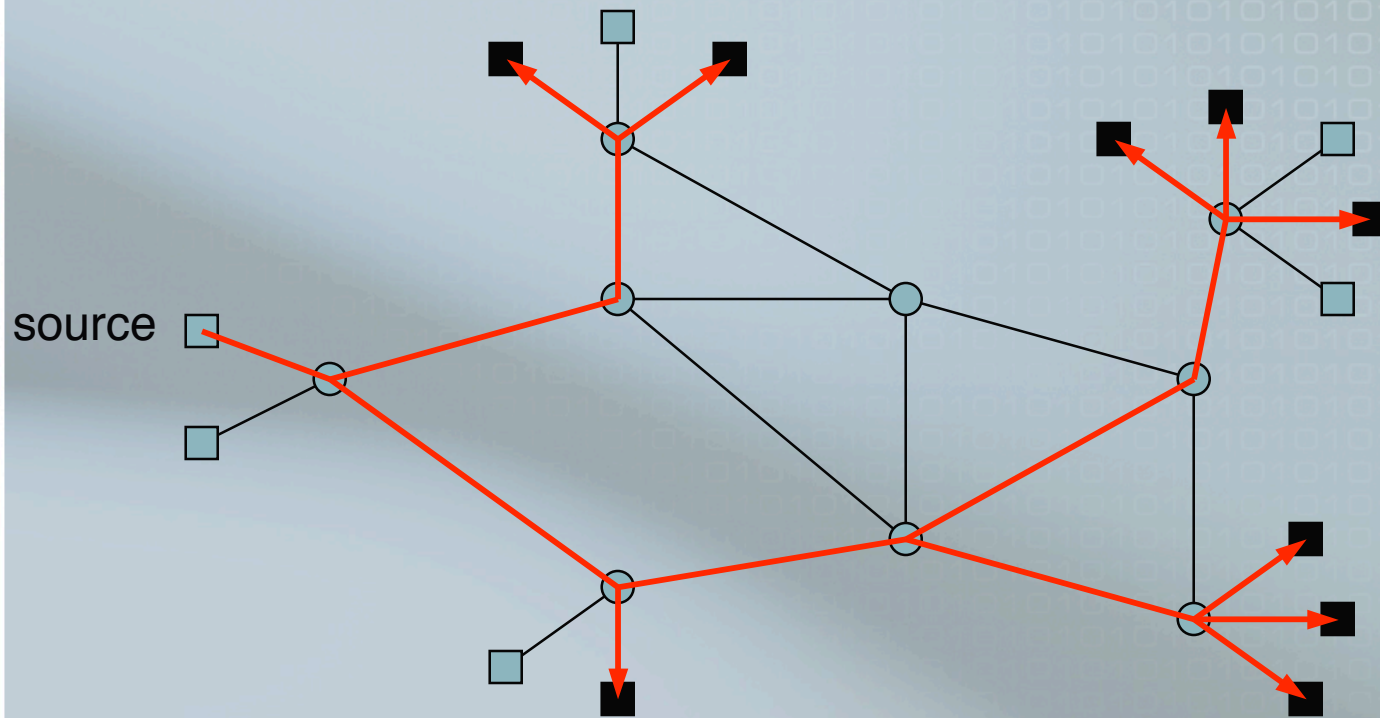
source

The Source can't afford the bandwidth !

The same traffic is going over one link multiple times



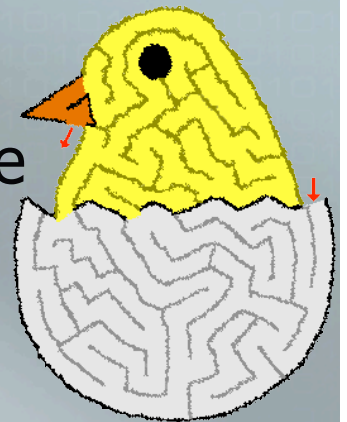
# IP-Multicast



Was born with WWW in early 90s,  
but deployment is far behind expectation !

# Deployment Problems

- Pricing: Routers are not paid for replicating packets.
- “Chicken and Egg ” problem:
  - There is no good software for multicast, because multicast protocols are not well supported.
  - Multicast protocols are not well supported, because there isn't high demand for it.
  - There isn't high demand for it, because there isn't good software...



# The Alternative to IP-Multicast

## ■ Application Layer Multicast

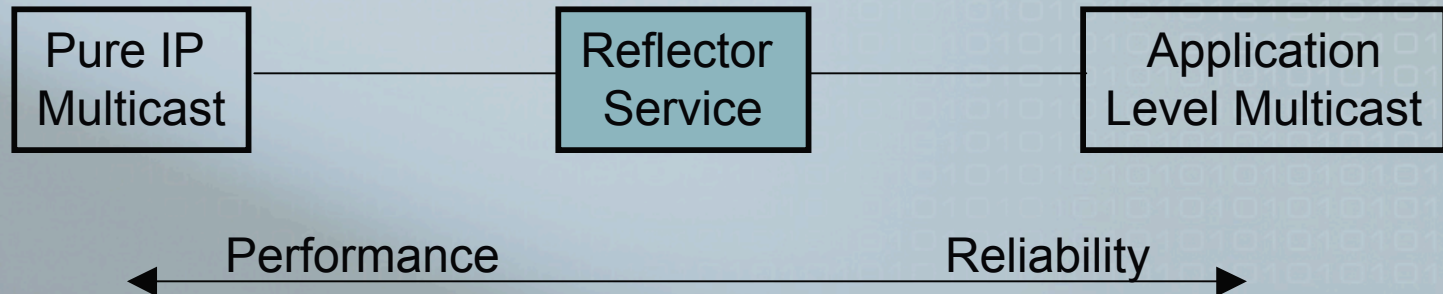
### ■ Pros:

- No need for router support
- Reliable

### ■ Cons:

- Not efficient
- Degraded quality and delay

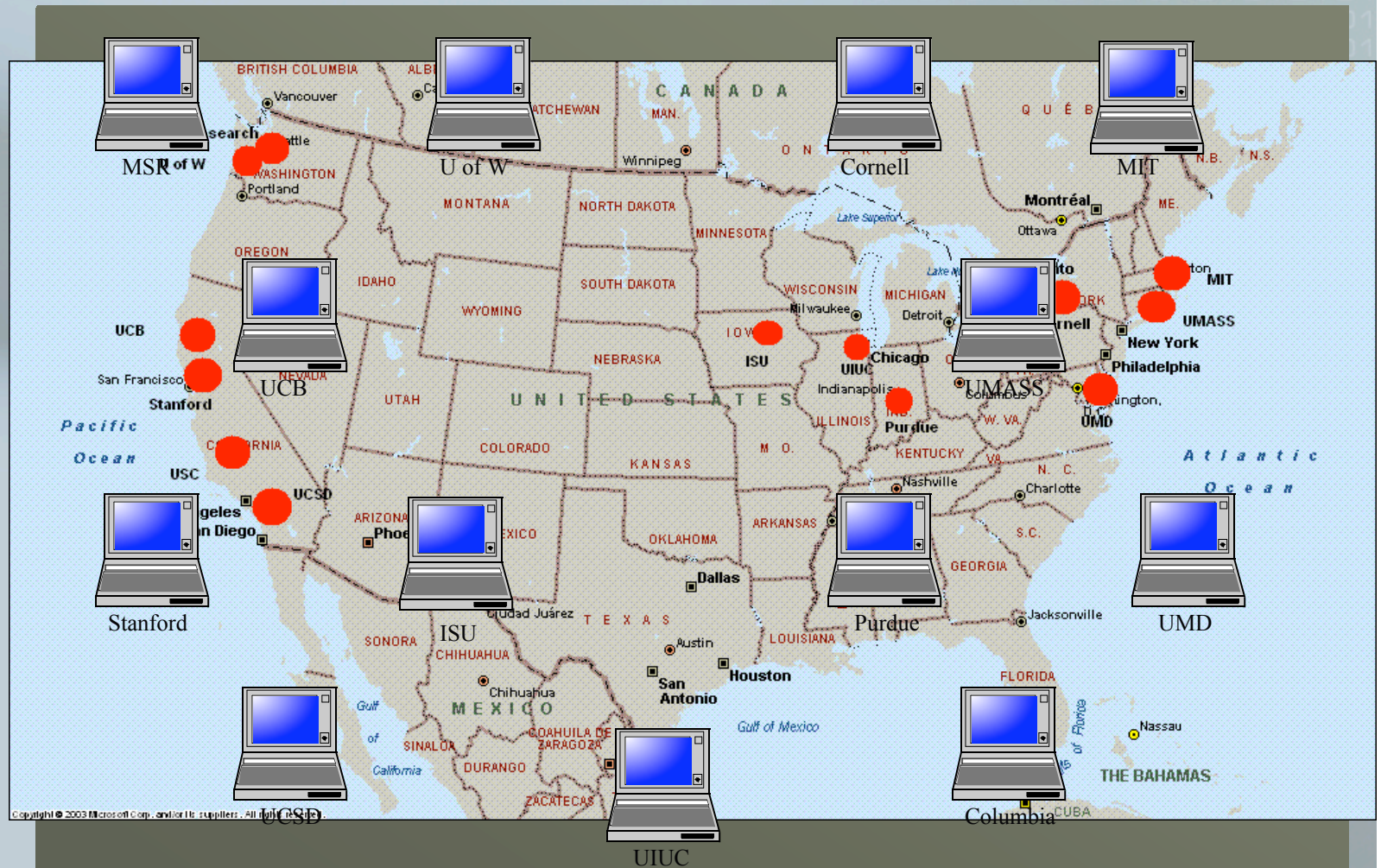
# Multi Reflector Service



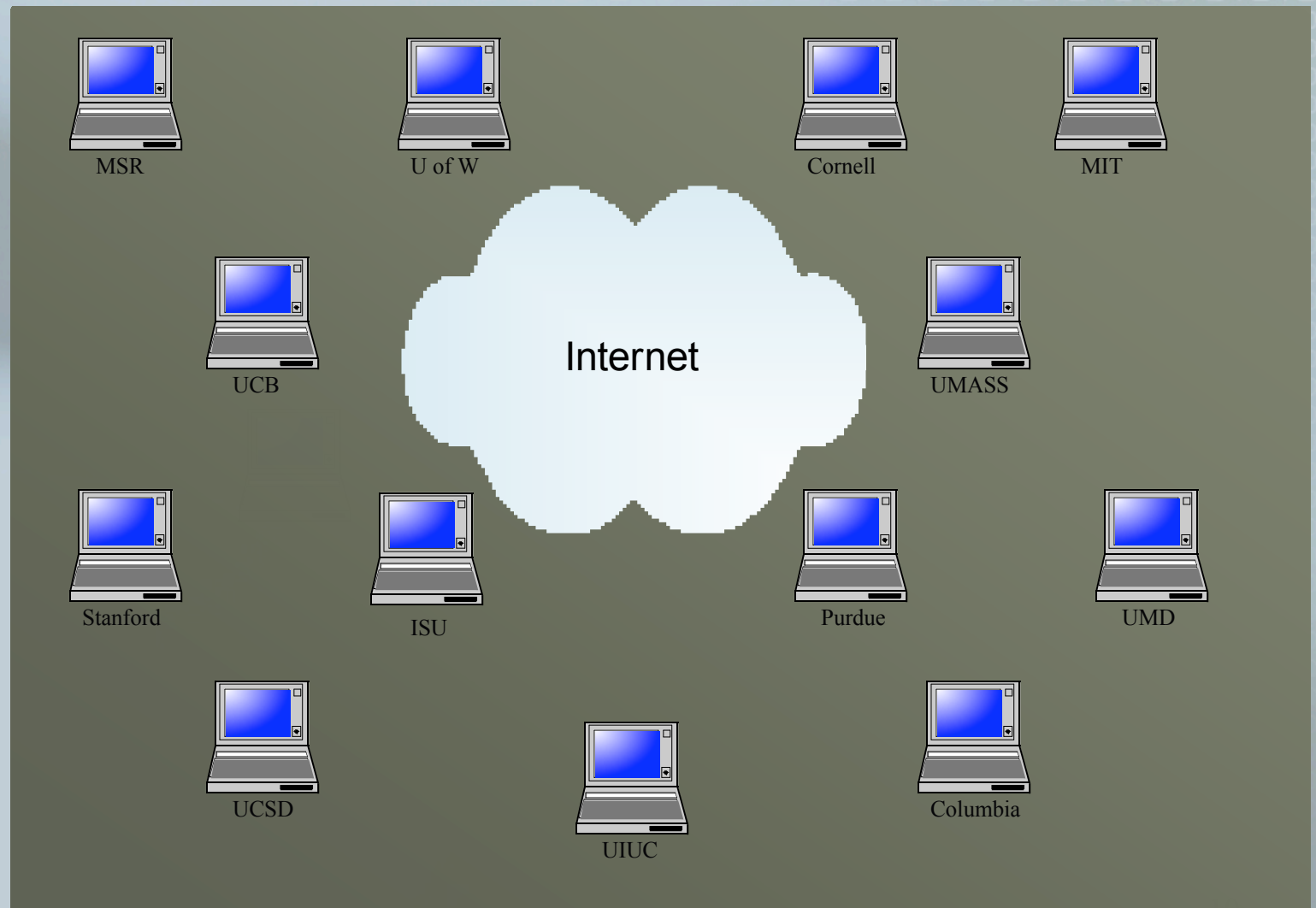
- Two extreme cases for the Reflector Solution:
  - Pure IP Multicast
  - Pure Application Level Multicast



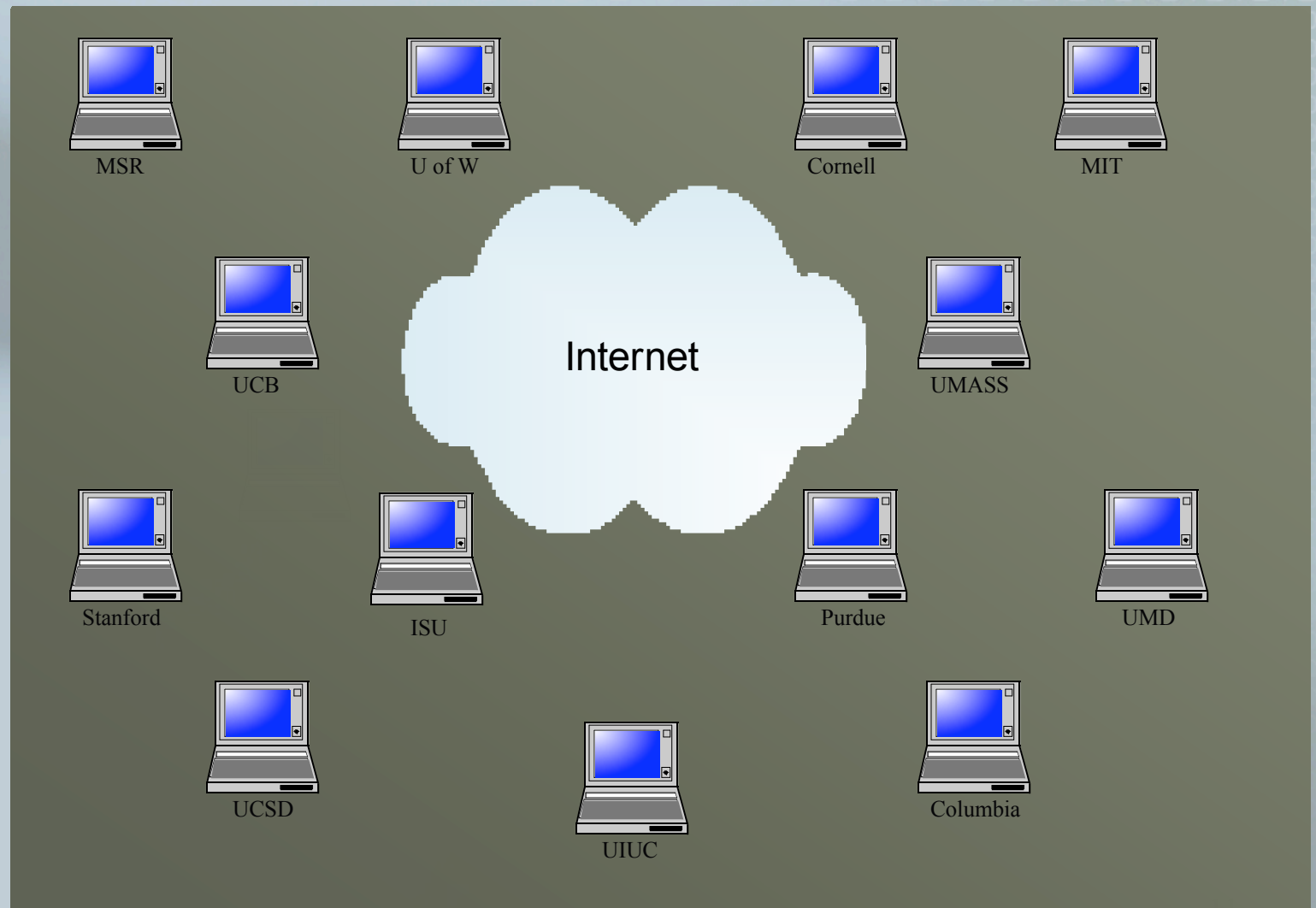
# Multi Reflector Service



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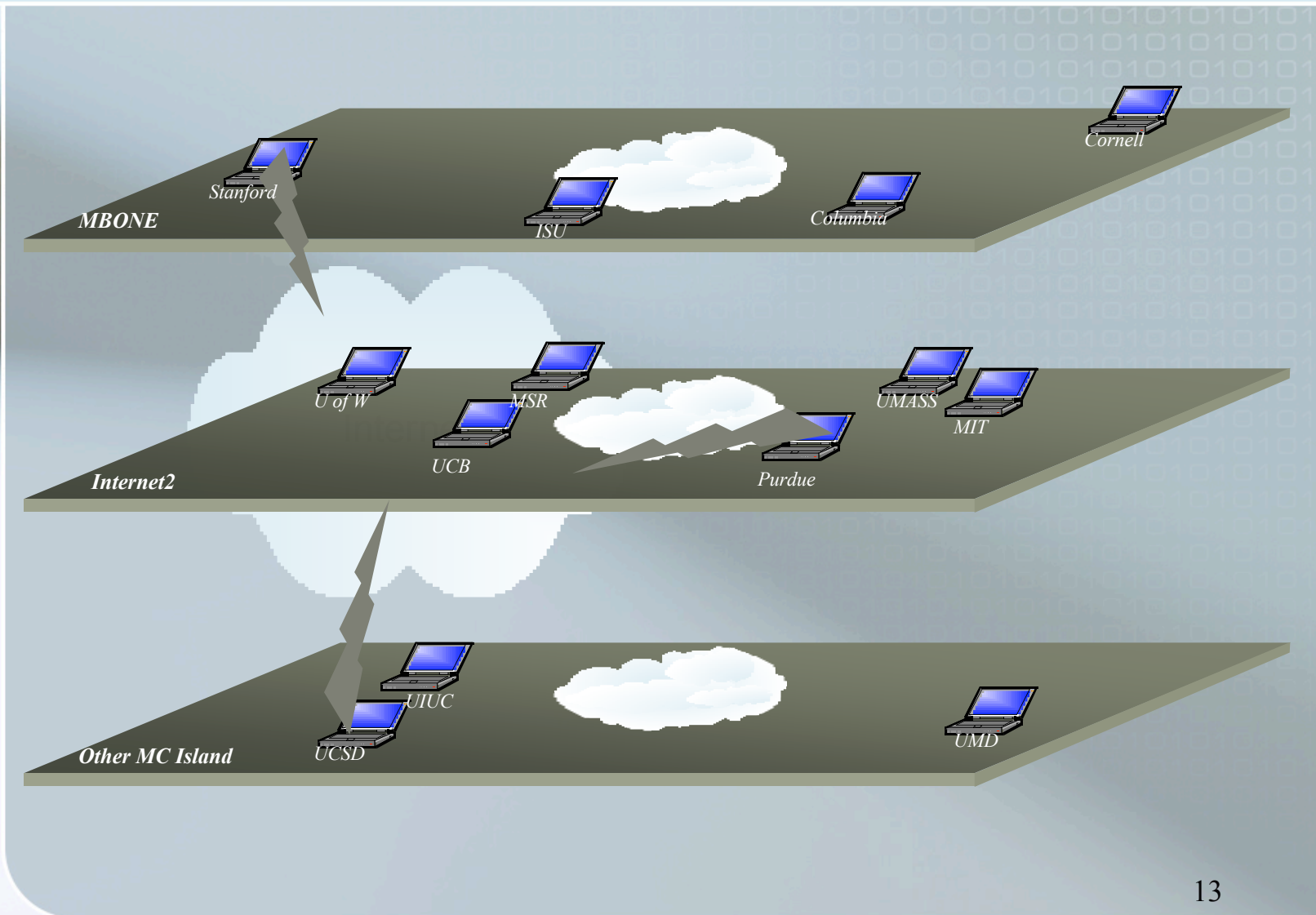


# Multi Reflector Service

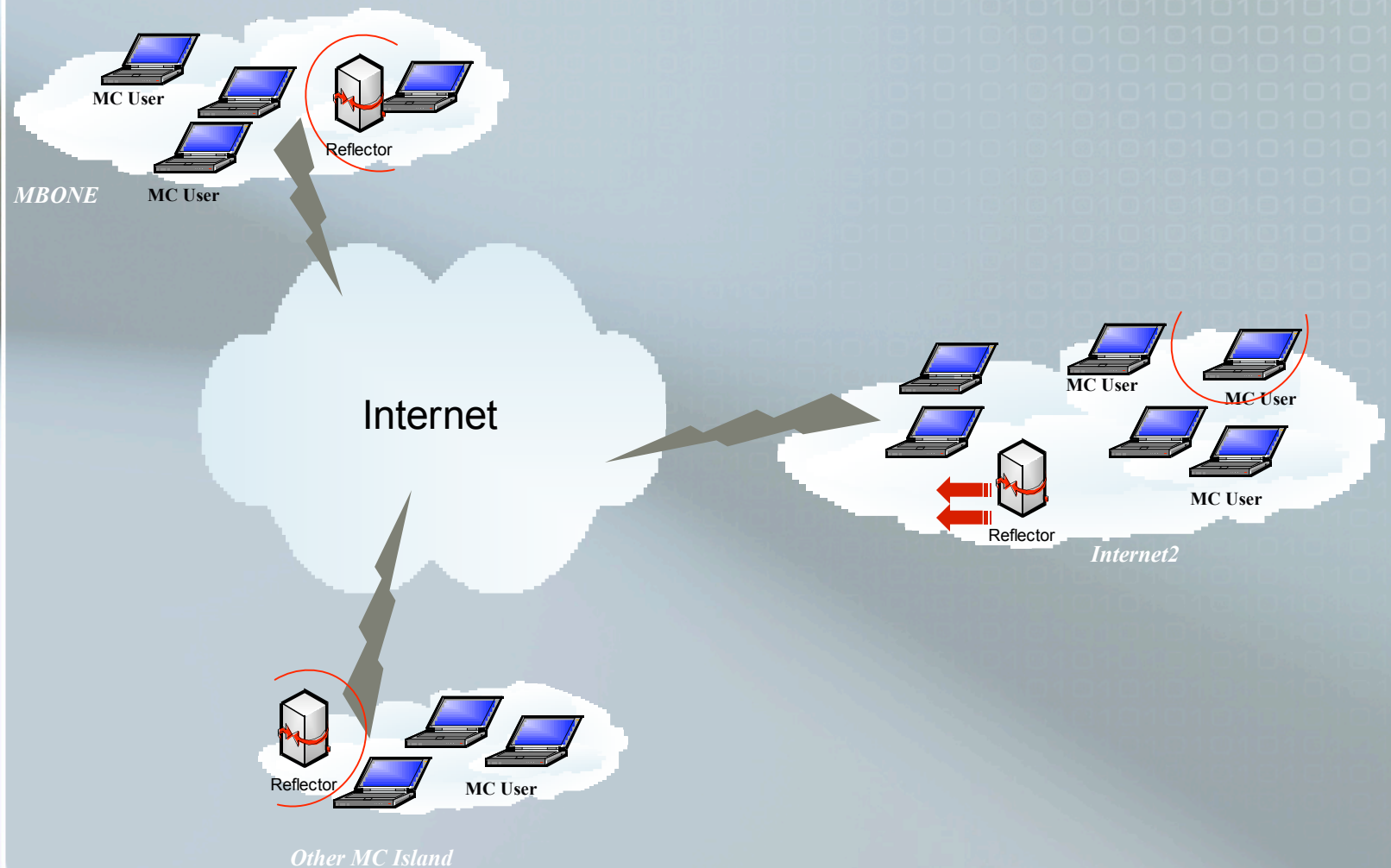




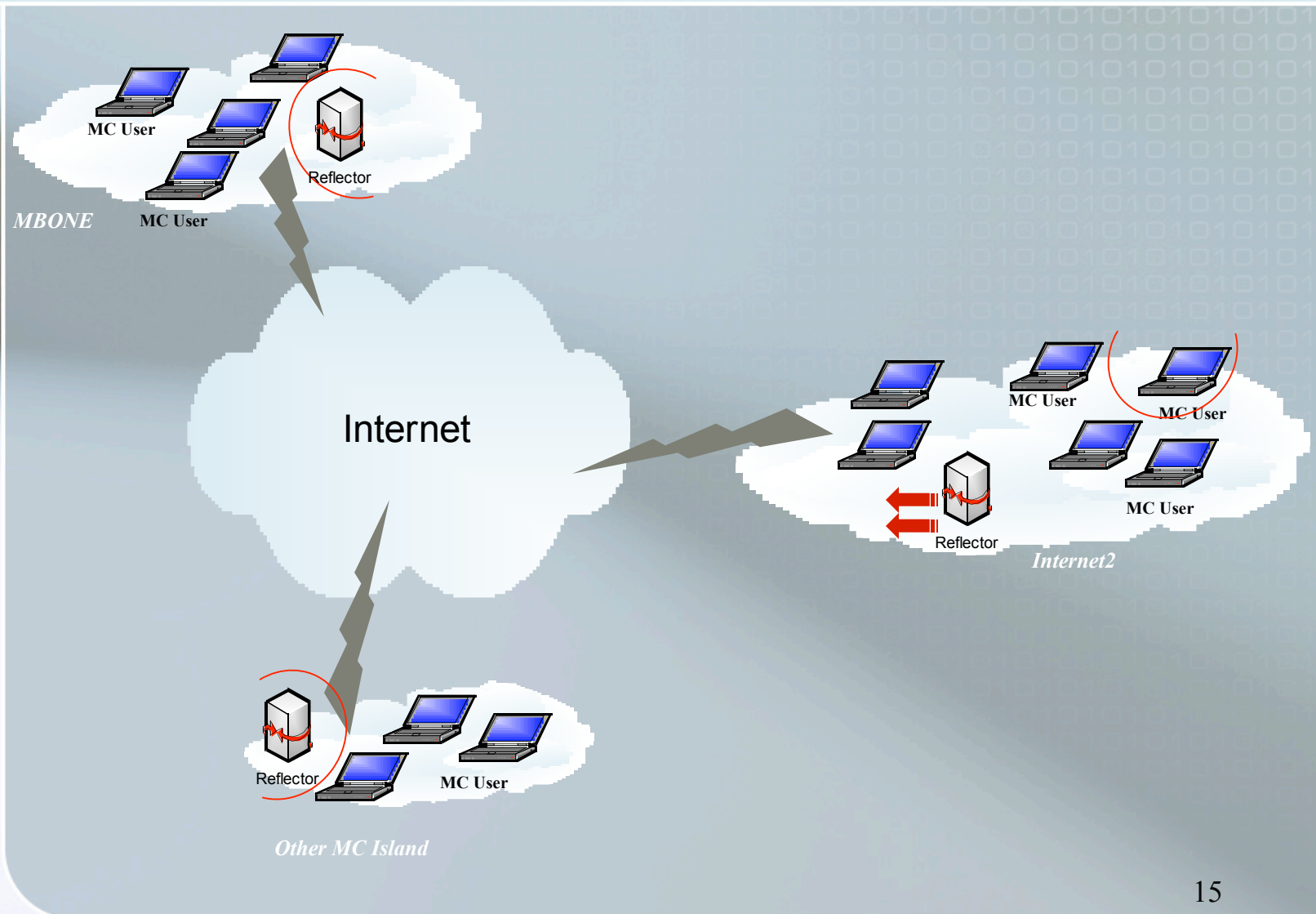
# Multi Reflector Service



# Multi Reflector Service



# Multi Reflector Service



# Multi Reflector Optimization

- Several optimization problems arise from:
  - Different problem constraints (e.g., number of reflectors per island and paths vs. flows)
  - Different objective functions (Minimum delay, Maximum Throughput, Minimum Congestion)
- Results:
  - We have proven some of these problems to be NP-Hard.
  - We have proposed polynomial time solutions to others and have studied and estimated the multicast capacity of the resulting network.

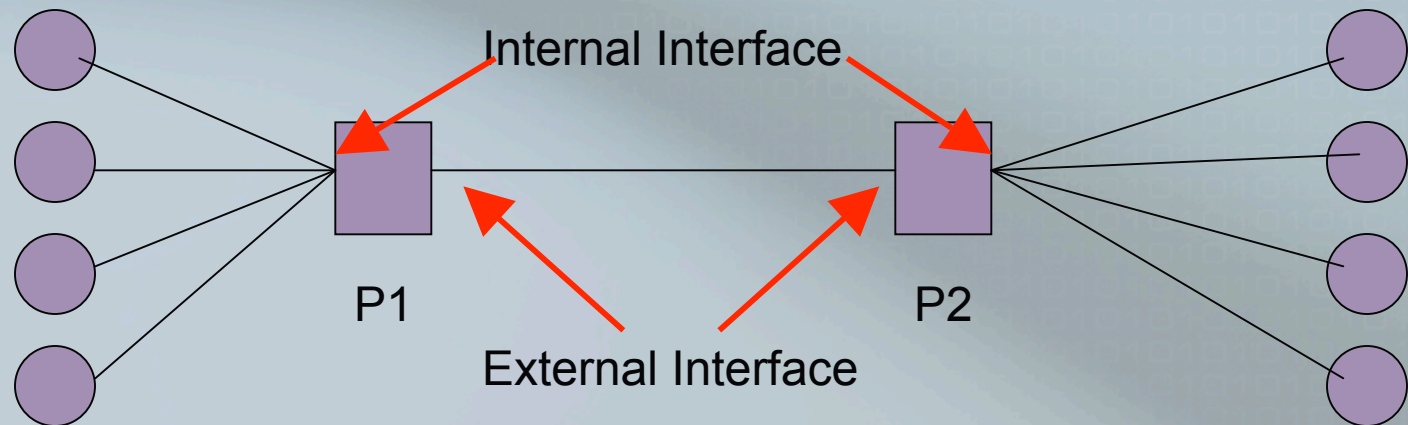


# The Multicast Game

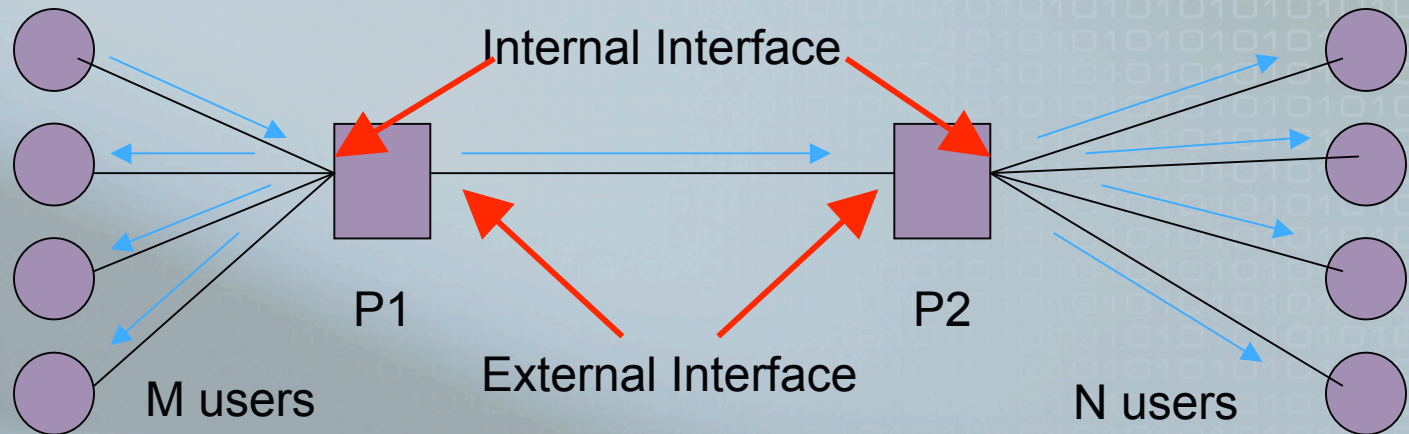
- What would happen if the Multi Reflector Multicast Solution gets deployed? Would it change the economics of multicast traffic?
- Game Definition
  - Players: Network Administrators in ISPs Controlling Routers
  - Available Strategies:
    - Enabling/Disabling ISP customers to receive IP-Multicast traffic from outside the ISP.
    - Enabling/Disabling ISP customers to send IP-Multicast traffic to outside of the ISP.
    - Enabling/Disabling ISP customers to send/receive IP-Multicast to/from between themselves.
  - Players' Cost: Their routing traffic.

# The Multicast Game: Simple Model

- Using a simplified model to
  - Investigate the effects of each player's action on other players.
  - Get insight to the dynamics of the game.

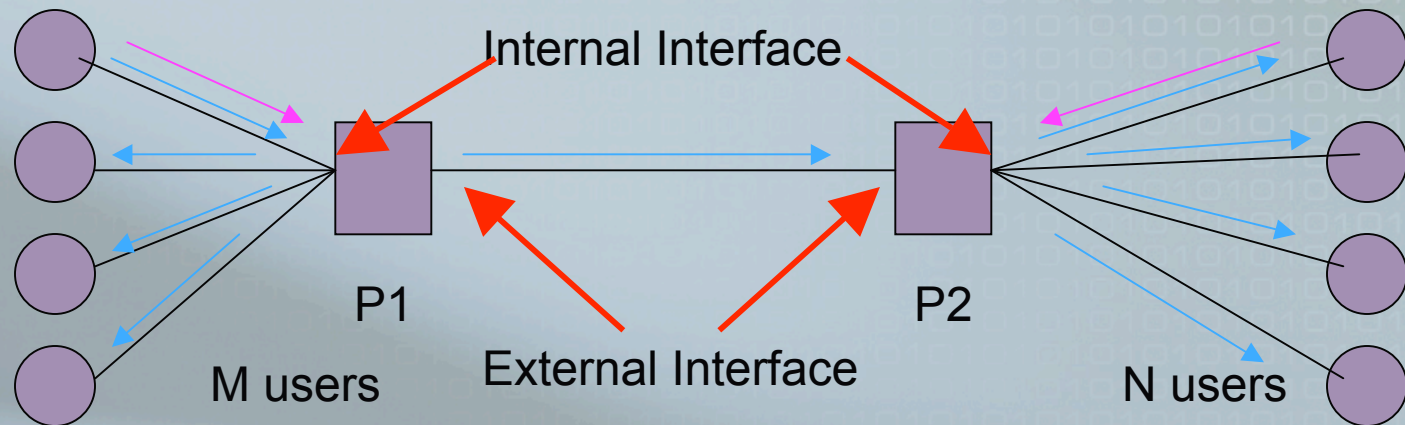


# The Multicast Game: Analysis



- P1 Strategy: EAI (Enable All Interfaces)
- P2 Strategy: EAI (Enable All Interfaces)
- P1 Cost: 1 in, M out
- P2 Cost: 1 in, N out

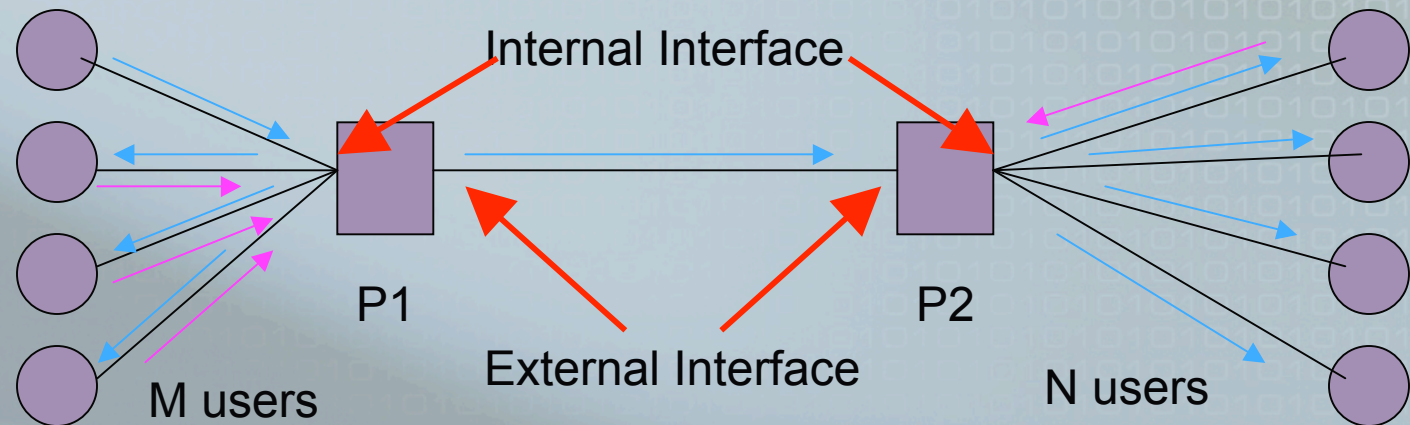
# The Multicast Game: Analysis



- P1 Strategy: DEI (Disable External Interface)
- P2 Strategy: EAI (Enable All Interfaces)
- P1 Cost: 2 in, M out
- P2 Cost: 2 in, N out

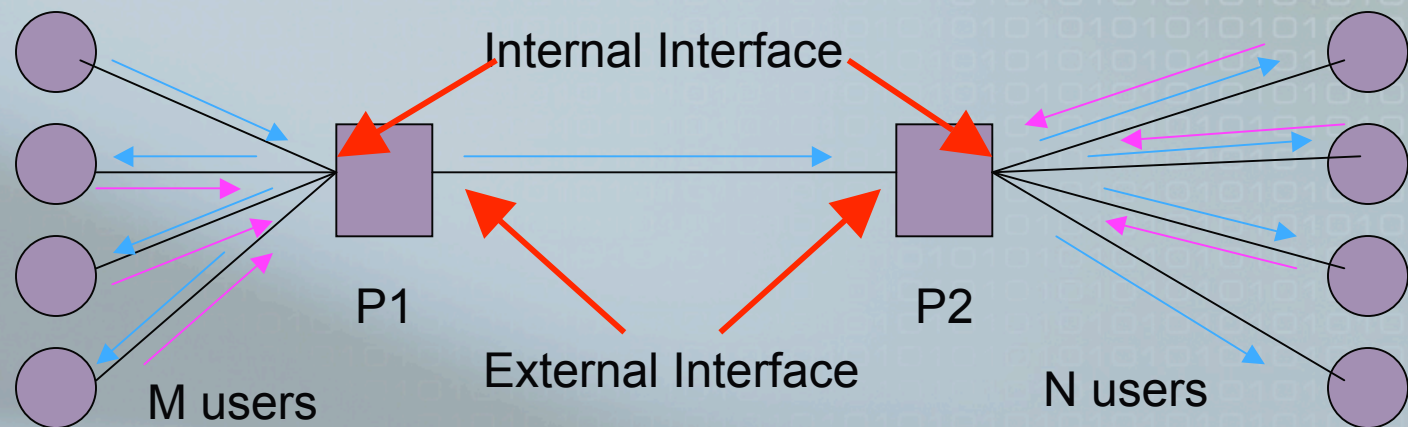


# The Multicast Game: Analysis



- P1 Strategy: DAI (Disable All Interfaces)
- P2 Strategy: EAI (Enable All Interfaces)
- P1 Cost:  $M$  in,  $M$  out
- P2 Cost:  $2$  in,  $N$  out

# The Multicast Game: Analysis



- P1 Strategy: DAI (Disable All Interfaces)
- P2 Strategy: DAI (Disable All Interfaces)
- P1 Cost:  $M$  in,  $M$  out
- P2 Cost:  $N$  in,  $N$  out

# The Multicast Game: Simple Analysis

P1 P2	DAI	DEI	EAI
DAI	(M,M) (N,N)	(2,M) (N,N)	(2,M) (N,N)
DEI	(M,M) (2,N)	(2,M) (2,N)	(2,M) (2,N)
EAI	(M,M) (2,N)	(2,M) (2,N)	(1,M) (1,N)

← P1

← P2

Weakly  
Dominating  
Strategy

(Packets Received, Packets Sent)

# Conclusion

- Disabling/Enabling multicast internally does not change other players cost, but it does change the player's cost. Therefore all rational users should enable multicast traffic internally.
- If External Interface is multicast disabled other player's actions does not change the cost of this player.
- Only if external interface is enabled others can change this player's cost.
- If the external interface is enabled for one player the cost could only get lower.
- Thus, in this simple model, all rational users should enable multicast traffic on all their interfaces, to get the maximum profit.



# Acknowledgement

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